The Potential of Solar Technologies in Wisconsin: Commercial Solar PV, Commercial Solar Thermal (Hot Water), and Residential Solar Thermal (Hot Water)

Notes from Meetings: February 15, 2005

A draft narrative document providing background material about the three solar markets was distributed by e-mail prior to the meeting. *Portions of that narrative are included and appear in italics.* The following meeting notes are organized around the Discussion Outline distributed at the meetings.

Resource Characterization: Solar Energy

Three of the markets addressed by this study are for solar technologies: commercial photovoltaics (solar PV), commercial/institutional solar thermal (water heating) and residential solar thermal. All three employ panels known as flat plate technologies. These panels, for both electrical generation (solar PV) and water heating (solar thermal), use the sun's ambient light and heat, and do not employ mirrors or other optical elements to concentrate the sun's energy. Therefore, they function well in both direct and diffuse sunlight, unlike solar concentrator technologies which require high concentrations of direct sunlight to function reliably. Solar concentrator technologies work best in locations like the desert of the Southwest which has few cloudy days. Flat plate technologies perform well in many climates with varying degrees of cloud cover such as the Upper Midwest.

The solar resource for flat plate systems in Wisconsin is characterized by the National Renewable Energy Laboratory (NREL) as "good," ranging from 4.0 to 5.0 kWh per square meter per day.[1] *Generally speaking, the potential is slightly higher in the western half of the state. Wisconsin's potential compares in range to the photovoltaic solar resource in Indiana, Ohio and Michigan, but is less than Minnesota and Illinois, and states farther west and south.*

A table from the U.S. DOE Energy Efficiency and Renewable Energy (EERE) web site[2] *shows a comparison of average photovoltaic system size requirements in different locations around the United States. While no location in Wisconsin is included, comparisons among a number of other Midwestern cities indicate that Wisconsin would fall well within the moderate potential range. Locations with extremes are shown for further comparison.*

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[1] National Renewable Energy Laboratory (NREL) Map, *PV Solar Radiation (Flat Plate, Facing South, Latitude Tilt), Annual average*. "Model estimates of monthly average daily total radiation using inputs derived from satellite and/or surface observations of cloud cover, aerosol optical depth, precipitable water vapor, albedo, atmospheric pressure and ozone resampled to a 40km resolution." Map at http://www.nrel.gov/gis/images/us_csp_annual_may2004.jpg

[2] (EERE data: www.eere.energy.gov/consumerinfo/makeeelectricity/eval_pv_collector_size.html)

City	*Meters^2 of PV panels required**
Albuquerque, NM	*6.4*
Los Angeles CA	*7.3*
Kansas City, MO	*8.4*
Bismarck, ND	*8.4*
Minneapolis, MN	*8.9*
Chicago, IL	*9.3*
Cleveland, OH	*10.0*
Seattle, WA	*11.1*
Anchorage, AK	*13.7*

**Comparison in square meters of PV panel system based on a comparable home that uses 6000 kWh/yr, obtains 25% from PV, and uses 10%-efficient flat plate collector facing south at latitude angle*

Solar technologies are particularly appropriate in urbanized settings. Both electric and thermal solar systems can be installed on existing buildings. These systems are quiet to operate and require little maintenance. Furthermore, both solar PV and solar thermal applications offset use of fossil fuels. Photovoltaic systems can replace coal and natural gas use, while solar thermal applications replace or augment the use of natural gas and propane.

The group offered no revisions to the text of the resource characterization in the narrative document. However, it was suggested that the national effective load carrying capacity resource map be included, along with the solar resource map for Wisconsin. There was also a question as to the usefulness of the comparison table showing square meter requirements for PV in different cities around the country.

Commercial Solar PV (9:00 AM – 11:30 AM)
Attendees:

John Ness, Xcel Energy
Paul Helgeson, PSCW
Eric Kostecki, Alliant Energy – WPL
Dave Toso, MGE
Ilze Rukis, WPSC
Bob Terrell, Alliant Energy – WPL
Carl Siegrist, WeEnergies
Laura Williams, MGE
Kevin Grabner, ECW
Don Wichert, WECC (Focus on Energy Renewable Energy Program)
Niels Wolter, MSB (Focus on Energy Renewable Energy Program)
Ingrid Kelley, ECW

Characterization of Solar PV
Economics are beginning to favor clean energy alternatives for commercial applications because of federal tax advantages, accelerated depreciation, and time-of-use utility rates. Furthermore, volatile fossil fuel markets, growing public pressure to increase regulatory

controls on greenhouse gasses, and new concerns about energy security are driving interest in solar PV among commercial and institutional power customers. New financing options, state and federal incentives, and easier access to grid interconnection also play an important role.

In recent years there has been notable growth in grid connected solar PV both nationally and internationally. A May, 2004 Solarbuzz report states that "37 Megawatts of grid-connected solar photovoltaics were installed in the United States in 2003. This represents growth of 32% over 2002 installations of 28 megawatts."[3] *While the residential market is currently growing the fastest, the potential for customer sited commercial PV installations is huge, as distributed generation (DG) strategies become more appealing to both businesses and utilities. For businesses with high quality power needs, a solar PV system with a battery bank can be integrated with a UPS system.*

The definition of commercial solar PV appearing in the narrative document was accepted by the group. It was agreed that BIPV is less likely to make a major expansion in the next five to ten years than retrofitted site-dedicated roof-top panel installations.

Market Channels and Actors

The group felt that while there will probably be a small number of building owners who undertake installation of PV systems on their own, the development of this market will more likely be accomplished by third party PV developers who either install site-dedicated systems and sell the power to the building owner, or lease roof or land space as independent power producers.

Motivations for Installing Commercial Solar PV in Wisconsin

The group agreed that most businesses need to find the economics of renewable energy to their advantage as their primary consideration. A number of potential motivators were mentioned.

While Wisconsin's geographic potential for solar energy is moderate, the effective load carrying capacity (ELCC) for photovoltaic applications in the state is excellent. According to NREL, which used utility load shape characteristics to map the ELCC for photovoltaics across the nation, "The intensity of the solar resource is obviously critical to PV power generation. But in determining PV's value to a utility, the magnitude of the sun's intensity is less important than its relationship to load requirements."[4] *Three characteristics of areas with a high ELCC are occurrence of intense summer heat waves, high daytime commercial power demand, and low demand for electric heat. Fitting this description well, Wisconsin mapped out in the two highest categories (60% -- 100%),*

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[3] Solarbuzz Inc., *US Grid Connect PV Market Report: A Review of 2003 Performance: A Look Forward to 2004 Outcomes*, May 2004. Citation for Report: http://www.solarbuzz.com/USGridConnect2004.htm

[4] U.S. DOE National Renewable Energy Laboratory, *Photovoltaics Can Add Capacity To The Utility Grid*, DOE/GO-10096-262 DE96000544, September 1996, www.nrel.gov/ncpv/documents/pv_util.html.

where the state's power demand curve is matched with the power production curve of solar electricity.

Other motivators mentioned:

- The price stability of solar peaking power
- The potential growth of the market for green credits
- Federal tax advantages
- Solar PV as part of green commercial building standards
- Demonstration of the business's environmental ethics
- Prices for PV equipment continue to drop

Barriers to Developing Wisconsin's Commercial Solar PV Potential

The group agreed that the most significant barrier to development of the commercial solar PV market is the lack of consistent public policy support from all levels of government. *Public policy and support has been found to be essential to jump start new renewable energy markets. A clear commitment to renewable energy on both state and federal levels will be necessary.*

Commitment by federal and state government has been anecdotal and sometimes conflicting. Without the guidelines state or federal support would provide, local government bodies often create a myriad of specialized ordinances and policies that increase costs and paperwork. Firm commitment to renewable technologies at the state level could assist in creating rate structures that would improve the economics for commercial solar PV.

Other barriers mentioned:

- The up-front costs of installing a system
- Customer behavior and preferences that reflect a lack of public awareness about solar technologies, including NIMBY reactions to a potential system installation by neighbors
- An immature REC market
- *Wisconsin is already ahead of many states with its new interconnection rule, which offers a consistent structure for grid connection of customer sited solar PV (and other distributed generation) systems. However, for commercial systems, the current net metering maximum of 20 kW can reduce the incentive for businesses to install larger systems. A more favorable utility rate structure will be necessary to fully realize the potential for commercial solar PV in Wisconsin.*
- *Both business owners and utilities need to become more aware of how solar PV works, and how it could benefit their energy bottom line over time. Perceptions of solar PV need to be updated to reflect advances in technology and changing energy economics.*
- *The number of installers in or near Wisconsin qualified to do large commercial systems will need to be increased.*
- *Supply of PV panels available – internationally there is a shortage of PV panels. This situation will probably be rectified as production comes up to meet demand.*

Program Approaches

The following are specific programs that should be used as models for estimating achievable potential for Wisconsin:

- Production tax credit (similar to wind)
- State sales tax exemption on equipment
- Property tax exemption
- Tax credits/accelerated depreciation
- RPS set-aside
- First-cost incentives
- Buy-back rates
- Strategies for bulk purchase of equipment
- Customer-driven green pricing (i.e. Community Energy Cooperative)
- Building code changes
- Net energy billing
- Education/marketing

Additional Comments, Suggestions and Resources

1. The present, small commercial solar PV market is driven primarily by environmental ethics and marketing; in the future, as economic advantages and public policy support accrue, the market will be developed by third-party solar electric utilities
2. The concept of raising the net metering maximum above 20kW will not necessarily increase the number of installed systems in and of itself. The average size of net metered systems is currently around 2kW.
3. There are three things that will drive future development of the commercial solar PV market:
    a. Favorable public policy and programs
    b. Price reductions for equipment
    c. Promotion of the environmental value of solar energy
4. We should be cautious about projecting price trends for PV systems because the international market is volatile for a number of reasons
5. Ideas for finding data for commercial solar PV scenarios:
    a. Other states have used two primary strategies: RPS set-asides and Public Benefits spending; CESA and DSIRE are both good sources of information about other states' public benefits programs and spending
    b. SEIA Solar Roadmap
    c. Time of use rates – map (L Krom)
    d. Analyze programs that have been effective in other states for getting commercial solar PV installed; look at money invested in the programs as compared to results; look at how other states set up their incentive program structure
    e. Talk to Sun Edison to find out what state program incentive levels they need to make their model work; ask about their price forecasts for installation (N Wolter)
    f. Construct supply/demand curves and note where factors cross and rates change

g. Use current program strategies and accomplishments as the base case scenario to build on
h. Tucson Electric did a study: Assuming 100% of roofs have PV, that would provide 10%n of Arizona's electricity. What would it be in Wisconsin?
i. Look to commercial solar PV markets in Japan, Spain and Germany to collect another set of data points for comparison

6. Contact Powerlight Corporation, a solar developer in California, for input on trends
7. Check out: *Commercial Solar Energy Market Potential Study: A Report for the National Renewable Energy Laboratory*; ECONorthwest, February 6, 2004

Commercial Solar Thermal (Hot Water) (12:30 PM – 2:00 PM)

Attendees:

Bob Ramlow, Artha Energy Systems (Focus on Energy, Renewable Energy Program)
Dave Toso, MGE
Ilze Rukis, WPSC
Bob Terrell, Alliant Energy – WPL
Scott A. Jones, Alliant Energy -- WPL
Laura Williams, MGE
Kevin Grabner, ECW
Don Wichert, WECC (Focus on Energy Renewable Energy Program)
Ingrid Kelley, ECW

Resource Characterization: Commercial Solar Thermal (hot water)

Like solar PV, solar water heating systems use flat plate, or non-concentrating solar collectors. Therefore the solar resource for water heating in Wisconsin is "good," ranging from 4.0 to 5.0 kWh per square meter per day.

Businesses benefiting the most from solar-heated water are those that use large volumes of hot water. These include car washes, hotels, health clubs, recreational facilities, and restaurants. Public institutions could also benefit including hospitals, nursing homes and retirement communities, college athletic facilities, public pools and transportation maintenance facilities. Factories that use warm or hot water in their manufacturing processes are also potential candidates. Multi-family housing with central water heating systems can also benefit from solar thermal technology.

The group accepted the definition of commercial solar PV appearing in the narrative document. In addition, the group agreed that the market for commercial solar thermal will be easier to identify than that for solar PV because there are only certain types of commercial businesses and institutions that use large quantities of hot water. Furthermore, this general market can be divided into two categories which can be loosely described as "short term thinkers" (laundromats, car washes and restaurants which are high-turnover, bottom-line oriented businesses) and "long-term thinkers" (academic institutions and businesses interested in future growth and development such as health facilities, hotels, commercial laundries, and food processing plants). These two groups

will need slightly different approaches to develop the potential for using solar thermal technologies.

Market Channels and Actors

- Appropriate businesses and institutions
    - Short-term planners who require a quick payback
    - Long-term planners who can tolerate a moderate to long payback
- Third-party solar hot water utilities
- School districts

Motivation for Installing Commercial Solar Thermal Technologies in Wisconsin

The solar resource in Wisconsin is sufficient to provide 40-50% of the energy required to heat water used in commercial businesses and institutions. Where water use is high, the savings are potentially significant. The most common source of energy for heating water in Wisconsin is natural gas. Prices of natural gas are volatile, but are generally rising. Payback calculations of ten years or less for installation of solar thermal technologies are rapidly becoming common, making this a reliable source of savings for the commercial sector.

The group agreed that both businesses and institutions will need to consider the economics first, but that with present FOE incentives and the economy of scale for larger systems, many systems can realize a positive cash flow immediately. A number of other potential motivators were also mentioned:

- Hedge against rising costs of natural gas and the advantage of purchasing future heating energy in advance
- The potential growth of the market for green credits
- Quality assurance of certification for both equipment and installation
- Federal tax advantages
- Demonstration of the business's environmental ethics and the value of green marketing
- Property and sales tax exemptions on equipment

Barriers to Development of the Commercial Solar Thermal Market in Wisconsin

The group identified the public's lack of knowledge or erroneous perceptions about solar hot water systems as being a major barrier. This is a residual barrier left over from the tax credit days of the 70's when many systems were poorly installed and later abandoned.

Other barriers that were mentioned:

- Shortage of investment capital to jump-start solar hot water utilities
- Shortage of installation and maintenance infrastructure
- Public perception of discounting the future by looking at energy cash flow instead of overall payback
- *Businesses are generally unaware of the potential energy savings available from using solar heated water*

- *Awareness and acceptance of new business models that allow business owners to turn to a "solar utility" for hot water rather than installing and maintaining a systems themselves, and availability of venture capital to develop such utilities.*

Program Approaches

The following are specific programs that should be used as models for estimating achievable potential of commercial solar thermal for Wisconsin:

- Financial incentives tailored to length of payback tolerance
- Education programs delivered through professional trade shows and web site
- Third party shared savings plan
- One-on-one "sales"/facilitation
- District demonstrations: working with a number of businesses in the same neighborhood or area

Additional Comments, Suggestions and Resources

1. With regard to the resale value of a commercial building, the presence of a solar thermal installation could be either an advantage or a disadvantage depending on the circumstances
2. Over the years, the cost of fossil fuel has risen at a greater rate than the price of solar thermal equipment or the costs of installation
3. We should look at long term business thinkers for the next five years and the short term business thinkers for the following five years
4. Ideas for finding data for commercial solar PV scenarios:
    a. DOA recently sent a mailing to potential commercial solar thermal customers; results may provide some data
    b. Talk to Solar Mining about their potential customer base

Residential Solar Thermal (Hot Water) (2:00 PM – 4:30 PM)

This meeting began an hour early because the previous meeting adjourned early. Because of this, the two representatives from the FOE Residential Program who did not attend the commercial solar thermal meeting did not arrive until after the residential solar thermal meeting was well underway.

Attendees:

Bob Ramlow, Artha Energy Systems (Focus on Energy, Renewable Energy Program)
Dave Toso, MGE
Ilze Rukis, WPSC
Laura Williams, MGE
Kevin Grabner, ECW
Don Wichert, WECC (Focus on Energy Renewable Energy Program)
Ingrid Kelley, ECW
Kathy Kuntz, WECC (Focus on Energy Residential Program)
Jack Jenkins, WECC (Focus on Energy Residential Program)

Resource Characterization: Residential Solar Thermal (Hot Water)

According to typical industry rules of thumb as laid out in Home Power Magazine,[5] panel area requirements for a solar water heating system based on climatic regions compare as follows:

Region	*Sq ft/gal of tank capacity**	*Total square feet*
Sunbelt	*1 sq ft/ 2 gal*	*40*
Southeast/Mountain States	*1sq ft/1.5 gal*	*60*
Midwest/Atlantic States	*1 sq ft/1 gal*	*80*
New England/Northwest	*1 sq ft/ .75 gal*	*107*

**Based on a household of four requiring an 80-gallon tank. These are general estimates. A specific analysis is required based on incoming water temperature, hot water temperature setpoint, actual usage and intensity of solar resource on site*

The sizing of these systems is intended to provide 100 percent of hot water in the summer and about 40% in the winter. Obviously, water conservation measures can improve the savings (and payback) potential. Solar systems are usually installed to augment the existing water heater so the home never runs out of hot water, but levels of use will determine what percentage of its hot water is solar heated.

In American households, heating water is a major energy expense. A typical electric water heater can easily use more than twice the electricity required by a refrigerator. The group offered no revisions to the text of the resource characterization in the narrative document.

The residential applications listed in the narrative document for this market included new and existing single family homes. This market was the focus of the group discussion until representatives from the FOE Residential Program asked the group to consider solar thermal for multi-family housing to be part of either the commercial or residential solar thermal markets. They presented case studies and data to show that this is a viable and growing market segment for solar thermal. The group discussed the similarities and differences of this segment when compared to the single-family and commercial markets. Comparing the multi-family market to the commercial market, the following points were considered:

- Multi-family housing installations incorporate a similar economy of scale to commercial installations, but the volume of hot water use is not generally as high as the primary commercial market identified in this potential study (high volume water users).
- Multi-family installations that have occurred so far have been done by owners concerned with environmental impact and long-term capital investment strategies. This is not necessarily the ownership demographic of multi-family residential developers in general.

[5] Olson, Ken, Solar Hot Water: A Primer, 2001, Home Power Magazine #84, August/September 2001. Download at http://www.homepower.com/files/olson84.pdf

(Note: A discussion of this issue will be taken up at an internal project meeting. Due to budget limitations, it is not possible at this time to add another separate renewable energy market, and multi-family solar thermal is sufficiently different from the two solar thermal markets being included that it would be both awkward and difficult to add it to either within the context of the present study.)

Market Channels and Actors

Installation of a residential solar water heater in Wisconsin is still most cost effective on new homes. However, the recent rapid increase in natural gas prices may soon make installation on an existing home very cost effective.

- Existing and new home owners
    - New "green" custom home purchasers: custom home buyers who want to incorporate clean and green energy measures may find that the net monthly mortgage cost of their solar water heater is lower than what they would pay per month for electric or even gas-heated water.
    - Owners of existing homes (with sufficient solar access) who are feeling the pinch of rising natural gas prices and wish to save on energy long-term.
- Home builders: "Green" home developers who are already building energy efficient housing developments can offer a solar hot water system as an option in their appliance package, and may combine solar hot water with a grid connected solar PV option as a "Zero Energy Home."
- Third-party solar hot water utilities

Motivations for Installing a Residential Solar Thermal System in Wisconsin

- Financing allows positive cash flow with current incentives
- Opportunity to demonstrate/engage environmental ethics
- Hedge against rising costs of natural gas and the advantage of purchasing future heating energy in advance
- Quality assurance of certification for both equipment and installation
- For new homes, solar access is usually excellent
- Proposed federal incentives for residential systems
- Property and sales tax exemptions on equipment
- Keeping energy dollars in the local economy
- *A solar thermal system can offset a significant portion of utility costs for heating water for a household in Wisconsin.*
- *Value of system added to resale value of house – can be recouped totally when house is sold (National Remodelers Assn)*

Barriers to Development of the Residential Solar Thermal Market in Wisconsin

The group identified the public's lack of knowledge or erroneous perceptions about solar hot water systems as being a major barrier. Consumers lack faith because of outdated perceptions of the solar hot water industry. This is a residual barrier left over from the tax credit days of the 70's when many systems were poorly installed and later abandoned.

Other barriers that were mentioned:

- Good solar orientation/access for existing homes is rare
- For new homes, solar thermal systems compete with other extras offered by builders
- First cost of systems and public perception of discounting the future by looking at energy cash flow instead of overall payback: consumers are not accustomed to doing life-cycle analysis on hot water costs
- Shortage of installation and maintenance infrastructure
- Aesthetics issues
- *Lack of system standardization: large variety of systems available can be confusing to public; systems tend to be "custom"*[6]
- *Getting plumbers interested in learning the other aspects required for installation*

Program Approaches

The following are specific programs that should be used as models for estimating achievable potential of commercial solar thermal for Wisconsin:

- Financial incentives comparable to those in the seventies when 3,000 systems a year were being installed
- Education and training of plumbing professionals for installation of solar thermal systems
    1. Mentoring
    2. Curriculum
    3. Training grants
- Education of new home builders about the technology
- Public education for new and existing home buyers and owners promoting the following:
    1. Current system reliability
    2. Existence of certification for both equipment and system installers
    3. Life-cycle costing and cash flow
    4. The importance of clean energy for the future
- Bullet-proof warranty and quality system commissioning

Additional Comments, Suggestions and Resources

1. With regard to the resale value of a home, the presence of a solar thermal installation could be either an advantage or a disadvantage depending on the circumstances
2. Over the years, the cost of fossil fuel has risen at a greater rate than the price of solar thermal equipment or the costs of installation
3. Compare data from the seventies to now – Don Wichert's study
4. Ideas for finding data for commercial solar PV scenarios:
    a. Look at data from other states with good residential solar thermal programs
    b. Talk with Chip Bircher about his knowledge of data availability, particularly in relation to the program he administered

[6] Solar Hot Water: A Conversation with Drew Gillett and Henry Vandermark, Fall 2000 issue of the Northeast Sun, published by the Northeast Sustainable Energy Association. Download at: http://www.nesea.org/publications/NESun/solar_hot_water.html

c. Contact Solar Energy Industries Association, San Francisco Municipal Utility District, Florida Solar Energy Center